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Timing of realimentation of mature cows that were feed-restricted during pregnancy influences calf birth weights and growth rates

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Timing of realimentation of mature cows that were feed-restricted during pregnancy influences calf birth weights and growth rates[1,2]

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ABSTRACT: The objective of this study was to determine the effect of feeding strategies in cows that allowed BW loss followed by BW gain on the efficiency of feed utilization for calf production. The first treatment (H-H-H) was designed to maintain body condition score of mature cows at 5.5 from the second trimester until the subsequent breeding season. The second treatment (L-H-H) was designed such that cows lost body condition during the second trimester and regained it during the third trimester and were equal in weight and body condition scores at parturition to cows assigned to the H-H-H treatment. The third treatment (L-L-H) was designed such that cows lost body condition during the second trimester and gained body condition after 28 d of lactation so that they would be equal to the other two treatments at breeding. Forty-eight cows were assigned to each treatment. Total DMI over the entire study did not differ between the H-H-H and L-H-H treatments ($P = 0.23$), but intake on both were higher than the L-L-H treatment ($P < 0.001$). Calf birth weight of the H-H-H treatment did not differ ($P = 0.43$) from those of L-H-H, but both groups were greater than those of the L-L-H ($P \le 0.002$) treatment. At 28 d of age, H-H-H ($P = 0.008$) and L-H-H ($P = 0.007$) calves weighed more than the L-L-H calves, but at 58 d of age there was no difference in calf BW among the treatments ($P = 0.81$). The percentage of cows that were diagnosed pregnant at weaning with their next calf did not differ ($P = 0.71$) among treatments. We interpret the results of this study to suggest that weight cycling in mature beef cows may be a viable management tool for decreasing food costs.

Key Words: Bovidae, Energy, Refeeding, Reproduction

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Introduction

In many cow-calf management programs, supplemental feed is provided during periods of limited-grazed-forage availability. This supplemental feed can represent a large proportion of the total cost of a cow-calf production system. The feed required for cow maintenance is positively correlated with her BW. The more a cow weighs, the more feed that is required to maintain her. However, fewer cows in low body condition at breeding become pregnant than cows in moderate body condition (Wiltbank et al., 1962; Bellows and Short, 1978; DeRouen et al., 1994). In the Dunn and Kaltenbach (1980) review of nutrition and postpartum interval, they concluded that positive weight gains during the prepartum interval will decrease the postpartum interval; however, the relationship between postpartum interval and weight gain is influenced by body condition at parturition. The results of Selk et al. (1988) and Whittier et al. (1988) corroborate the conclusions of Dunn and Kaltenbach (1980) and suggest that reproductive performance can be maintained in cows that weight-cycle during pregnancy.

Freetly and Nienaber (1998) demonstrated that the mature nonpregnant-nonlactating cow is relatively efficient in gaining body energy following body energy loss, suggesting that weight cycling could be used to decrease the use of harvested feed and allow better use of grazed forage. Based on the above results, we propose that advantages of deferred feed intake in the nonpregnant-nonlactating cow can be applied to the pregnant and lactating cow. The objective of this study was to determine the effect of weight cycling through nutritionally induced weight loss during the second trimester and subsequent weight gain during pregnancy or lactation on feed intake, cow and calf weight gain, and pregnancy rates.

Materials and Methods

Two hundred sixty-two mature MARC III (four-breed composite: ¼ Angus, ¼ Hereford, ¼ Pinzgauer, ¼ Red

[1]The authors acknowledge the technical support of Chris Haussler.

[2]Names are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the product, and the use of the name by USDA implies no approval of the product to the exclusion of others that may also be suitable.

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Poll; 6.5 ± 0.2 yr) cows were injected with 25 mg of $PGF_{2\alpha}$ in November. Twelve days following the first injection, cows received a second injection (25 mg) and were placed with Simmental bulls for 7 d. Eighty-three days following bull removal, pregnancy was confirmed with ultrasound and 144 of the 146 bred cows were placed on study. Cows were randomly assigned within age to each of the treatments. The first treatment (**H-H-H**) was designed to maintain a body condition score (**BCS**, 9-point scale) of 5.5 from the second trimester until breeding. The second treatment (**L-H-H**) was designed for cows to lose body condition during the second trimester, regain it during the third trimester, and be equal in weight and BCS at parturition to those in the H-H-H treatment. The third treatment (**L-L-H**) was designed for cows to lose body condition during the second trimester and gain body condition after 28 d of lactation so that they would be equal to the other two treatments at breeding. Forty-eight cows were assigned to each treatment. Cows were penned four cows to a pen and fed individually by use of Calan electronic headgates (American Calan Inc., Northwood, NH). Seven cows did not adapt to individual feeders and were removed from study, resulting in 137 continuing on study at the beginning of the feed restriction.

Body condition was measured on a 9-point scale (NRC, 1996) and was the average of two independent scores. Initial BW was 557 ± 5 kg and initial BCS was 5.6 ± 1. During gestation, the daily offered metabolizable energy was equal to metabolizable energy required for maintenance (**ME_m**) plus the metabolizable energy required for pregnancy (**ME_p**). Metabolizable energy for maintenance was based on BW at a BCS of 5.5, which was calculated as the cow's BW plus 45 kg for every BCS less than 5.5 or minus 45 kg for every BCS over 5.5 (NRC, 1996). From 83 to 118 d after mating, all cows were provided feed to achieve a ME_m intake of 165 kcal ME/kg $BW^{0.75}$; however, after 118 d, treatments differed in their assigned ME_m (Table 1). All treatment groups received the same amount of ME_p. Metabolizable energy for pregnancy was calculated as described by NRC (1996): ME_p (kcal/d) = 36.3(0.4504 − 0.000766t)exp[(0.03233 − 0.0000275t)t] where t is equal to days after mating. Calf birth weight was estimated to be 36.3 kg based on the herd average from the previous year. All cows were assumed to be the same number of days pregnant, and ME intakes were adjusted every 7 d for number of days pregnant.

During lactation, the daily offered metabolizable energy was equal to metabolizable energy required for maintenance plus the metabolizable energy required for lactation (**ME_l**). Metabolizable energy for maintenance was assigned as described in Table 1. Metabolizable energy for lactation was calculated as milk yield multiplied by milk energy divided by efficiency of milk production. Milk yield was estimated from regression equation developed in heifers of a similar breed type (Freetly and Cundiff, 1998) with a correction for mature cows of 1.35 (NRC, 1996):

Table 1. Assigned metabolizable energy for maintenance (ME_m) intakes,[a] kcal/d

	ME_m, kcal ME/kg $BW^{0.75}$		
Item	H-H-H	L-H-H	L-L-H
Days after mating			
83–118	165	165	165
119–149	165	130	130
150–215	135	90	90
216 to parturition	135	180	90
Days of lactation			
0–27	135	135	90
28–30	135	135	142
31–33	135	135	195
34–36	135	135	248
37 to breeding (~58 d)	135	135	300

[a]H-H-H = maintain a body condition score (BSC) of 5.5 from the second trimester until breeding; L-H-H = decline in BCS in the second trimester and reattain the BCS in the third trimester to match the H-H-H cows in weight and BCS at parturition; L-L-H = decline in BCS in the second trimester and reattain the BCS after 28 d of lactation to match the cows of the other two treatments.

$$\text{Milk (kg/d)} = 0.00000137t^3 - 0.00071242t^2 + 0.081007t + 6.880$$

where t = d postpartum. Milk energy was assumed to have a density of 759.1 kcal/kg (NRC, 1996), and the efficiency of production was assumed to be 0.70 (Moe et al., 1972).

Feed composition remained the same the entire time that cows were individually fed. On a DM basis, the diet contained 67.3% corn silage, 27.0% chopped alfalfa hay, 5.5% soybean meal, and 0.2% sodium chloride. The calculated ME of the feed was 2.39 Mcal/kg, and the diet averaged 14.2% CP and 91.3% OM. The diet was formulated such that only energy was limited during restriction. Cows received one meal each morning and orts were determined every 7 d.

During pregnancy and lactation, cows and calves were weighed every 14 d. Cows and calves were also weighed at parturition and when calves were 28 d of age. Male calves were castrated at birth. Cows were placed in a 32-ha pasture in November with Simmental bulls for breeding when calves were between 55 and 61 d of age (average = 58.4 ± 0.2). Cows were with bulls 57.0 ± 0.6 d. Bulls were removed on December 29, and cows were palpated 113 d later to diagnose for pregnancy. During breeding, cows received 15.4 kg DM/d of a diet containing 55.4% corn silage and 44.6% alfalfa haylage on a DM basis in addition to pasture. Experimental procedures were conducted in accordance with the Meat Animal Research Center Animal Care Guidelines and the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (FASS, 1999).

Cow and calf rates of gain were determined as the first derivative of the regression of BW on time. Because cow BW on time was described by a quadratic equation for the first 28 d after parturition, the rate of BW gain with respect to time is described as a linear function of days postpartum. After 28 d from parturition, body weight on time was a linear function for cows resulting in a constant estimate for BW gain. Body weight on time was described by a linear function for calves both under and over 28 d of age, which resulted in a constant estimate for BW gain.

Cow and calf 58-d and 205-d BW were calculated to adjust for differences in days postpartum at breeding and weaning. Fifty-eight-day weights for cows and calves were calculated as the rates of gain between 28 d of lactation and breeding multiplied by 30 d plus the 28 d BW. Two hundred and five-day weights were calculated as [(ADG from d 58 to weaning) × 147-d BW] + 58-d BW.

Cow BW gain, BW, age, BCS, and DMI were analyzed as a one-way ANOVA with treatment as the sole factor. Means were tested using single-degree-of-freedom contrasts. Data were analyzed using the GLM procedure in SAS (SAS Inst. Inc., Cary, NC). The probability that treatments differed in the proportion of animals that did not abort and the proportion of cows that were pregnant were tested using maximum likelihood estimates with treatment as the sole fixed variable. Data were analyzed using the GENMOD procedure of SAS (SAS Inst. Inc., Cary, NC) with a binomial distribution specification. Calf BW gain and BW were analyzed as a two-way ANOVA with treatment and sex and the interactions as sources of variation. Means were tested using single-degree-of-freedom contrasts. Data were analyzed using the GLM procedure of SAS (SAS Inst. Inc., Cary, NC). Means with probabilities less than 0.05 were considered to be different.

Results

During the experiment, 20 cows were removed from the study (Table 2). Treatments did not differ in number of cows removed for any given cause.

By design, daily DMI during the second trimester was higher for the H-H-H treatment ($P < 0.001$) than for the L-H-H and L-L-H treatments, which did not differ from one another ($P = 0.74$; Table 3). During the third trimester, daily DMI was different across all treatments ($P < 0.001$) and ranked L-H-H > H-H-H > L-L-H. During the first 28 d of lactation, daily DMI did not differ for the H-H-H and L-H-H treatments ($P = 0.45$), but both were higher than the L-L-H treatment ($P < 0.001$). From 28 d of lactation until breeding, daily DMI did not differ for the H-H-H and L-H-H treatments ($P = 0.99$), but both were lower than the L-L-H treatment ($P < 0.001$). Total DMI over the entire study did not differ between the H-H-H and L-H-H treatments ($P = 0.23$), but both were higher than the L-L-H treatment ($P < 0.001$).

Changes in BW and BCS of cows followed the same pattern as feed intake (Table 4). At the beginning of the third trimester, cows on the H-H-H treatment weighed more than the L-H-H treatment ($P = 0.004$), and tended to be heavier than the L-L-H treatment ($P = 0.11$). The L-H-H and L-L-H treatments did not differ ($P = 0.19$) in BW. At the start of the third trimester, the H-H-H treatment had a higher BCS score than either the L-H-H or L-L-H ($P < 0.001$) treatments, and the L-H-H and L-L-H treatments did not differ ($P = 0.19$) in BCS. At parturition, the BW of the cows on the H-H-H treatment did not differ from those on the L-H-H treatment ($P = 0.69$); however, both were greater ($P \leq 0.006$) than the L-L-H treatment. Birth weights of calves with L-L-H dams were lower than calves with L-H-H ($P = 0.002$) or H-H-H dams ($P < 0.001$); Table 5). By 58 d of age, calf BW did not differ ($P = 0.81$) among treatments.

Although there was a treatment difference in cow BW at parturition (Table 4), there was not a difference in the BW gain with respect to days postpartum during the first 28 d among treatments: $d^2\mathrm{BW}/dt^2 = 0.282t - 4.23$. Cows lost weight at a decreasing rate during the first 15 d postpartum and subsequently gained weight at an increasing rate during the next 13 d. Calf BW gain during the first 28 d was a constant that did not differ among treatments ($P = 0.36$), but gain in male calves (1.12 ± 0.03 kg/d) was greater than that in female calves (1.03 ± 0.03 kg/d; $P = 0.045$). With increased feed intake, the L-L-H cows gained weight more rapidly from

Table 2. Causes for cows being removed from study

				Injured/died during					
				Parturition		Lactation			
Treatment[a]	n	Aborted	Twins	Cow	Calf	Cow	Calf	Mastitis	Total
H-H-H	46	1	1	1	0	0	2	0	5
L-H-H	44	3	1	1	0	2	0	1	8
L-L-H	47	3	0	0	1	1	1	1	7
Total	137	7	2	2	1	3	3	2	20

[a]Treatments differed in ME allotted for maintenance (Table 1) but received equal allotments of ME for pregnancy and lactation. H-H-H = maintain a body condition score (BSC) of 5.5 from the second trimester until breeding; L-H-H = decline in BCS in the second trimester and reattain the BCS in the third trimester to match the H-H-H cows in weight and BCS at parturition; L-L-H = decline in BCS in the second trimester and reattain the BCS after 28 d of lactation to match the cows of the other two treatments.

Table 3. Average daily dry matter intakes (kg/d) and total dry matter intake (kg)

Treatment[a]	Pregnancy n	2nd Trimester	3rd Trimester	Lactation n	0 to 28 d	n	28 d to breeding	Total DMI[b]
H-H-H	44	7.19 ± 0.09[c]	8.44 ± 0.08[c]	42	10.11 ± 0.10[c]	41	10.18 ± 0.09[c]	1,867 ± 19[c]
L-H-H	40	5.45 ± 0.14[d]	10.43 ± 0.10[d]	38	10.20 ± 0.09[c]	37	10.18 ± 0.09[c]	1,833 ± 22[c]
L-L-H	44	5.41 ± 0.07[d]	6.47 ± 0.07[e]	40	8.18 ± 0.07[d]	40	15.90 ± 0.23[d]	1,671 ± 19[d]
Days		98 ± 6	68 ± 1		28 ± 0		30 ± 0	
$P < F$								
Treatment		<0.001	<0.001		<0.001		<0.001	<0.001

[a]Treatments differed in ME allotted for maintenance (Table 1) but received equal allotments of ME for pregnancy and lactation. H-H-H = maintain a body condition score (BSC) of 5.5 from the second trimester until breeding; L-H-H = decline in BCS in the second trimester and reattain the BCS in the third trimester to match the H-H-H cows in weight and BCS at parturition; L-L-H = decline in BCS in the second trimester and reattain the BCS after 28 d of lactation to match the cows of the other two treatments.
[b]Calculated as individual average daily DMI times the average number of days in a feeding period.
[c,d,e]Within a column, means without a common superscript letter differ ($P < 0.05$).

28 d postpartum until breeding than did the H-H-H ($P < 0.001$) or the L-H-H ($P < 0.001$) cows (Table 6). The rate of gain over the same period did not differ between the H-H-H and L-H-H treatments ($P = 0.76$). During this same period, calves with L-L-H dams gained weight more rapidly than did calves with H-H-H ($P = 0.03$) or L-H-H ($P = 0.01$) dams. Average daily gain did not differ between the H-H-H and L-H-H calves ($P = 0.71$). From 28 through 58 d of age, male calves (1.00 ± 0.04 kg/d) gained weight more rapidly ($P = 0.03$) than female calves (0.90 ± 0.03 kg/d). From 58 d to 205 d, female calves (0.86 ± 0.03 kg/d) gained weight more rapidly ($P = 0.03$) than male calves (0.76 ± 0.03 kg/d).

Treatments did not differ in the percentage of cows that carried a calf to term (95%; $P = 0.49$). Ninety-eight percent of the H-H-H, 93% of the L-H-H, and 94% of the L-L-H cows carried a calf to term. Treatments did not differ in the number of cows that were diagnosed pregnant with a second calf (91%; $P = 0.71$). Ninety-three percent of the H-H-H, 92% of the L-H-H, and 88% of the L-L-H cows were pregnant with a second calf.

Discussion

The economic efficiency of the cow herd is partially dependent on strategically matching feed resources with the rest of the production system. In many forage-based production systems, there are periods during which nutrient availability from grazing is limited. These periods of limited nutrients are frequently followed by a period during which nutrient availability from grazing exceeds animal requirements. Allowing cow BW to fluctuate with nutrient availability is a potential management option that could reduce the cost of calf production. However, incorrect timing of nutritional restriction can decrease reproductive performance. Cows that calve at low BCS (< ~5) have longer postpartum intervals than do cows that calve at high BCS (Wiltbank et al., 1962; Bellows and Short, 1978; Bellows et al., 1982). The impact of longer postpartum interval on pregnancy rate is dependent on the time that breeding commences and the length of breeding season. Because reproductive performance is sensitive to nutritional status, it is important to determine the time points in the production cycle when nutritional restriction can be imposed and when refeeding must start to avoid impaired reproductive performance. The conclusion of several studies is that cows that achieve a good BCS before parturition will be reproductively successful (Dunn and Kaltenbach, 1980; Selk et al., 1988; and Whittier et al., 1988). The results of this study are in agreement with this conclusion. However,

Table 4. Body weight and body condition score of mature cows

Days from parturition	Cow wt, kg H-H-H[a]	L-H-H[a]	L-L-H[a]	$P < F$ Treatment	Body condition score[b] H-H-H[a]	L-H-H[a]	L-L-H[a]	$P < F$ Treatment
−190	553 ± 9	550 ± 9	568 ± 10	0.33	5.5 ± 0.1	5.5 ± 0.1	5.8 ± 0.1	0.08
−95	599 ± 9[c]	560 ± 9[d]	577 ± 10[cd]	0.02	6.0 ± 0.1[c]	5.3 ± 0.1[d]	5.4 ± 0.1[d]	0.001
0	590 ± 9[c]	585 ± 9[c]	549 ± 10[d]	0.002	5.6 ± 0.1[c]	5.5 ± 0.1[c]	4.8 ± 0.1[d]	0.001
+28	563 ± 9[c]	557 ± 9[c]	513 ± 10[d]	0.004	—	—	—	—
+58	556 ± 9[cd]	547 ± 10[c]	584 ± 11[d]	0.04	5.2 ± 0.1	5.1 ± 0.2	5.2 ± 0.2	0.77
+205	588 ± 9	571 ± 9	575 ± 11	0.47	—	—	—	—

[a]Treatments differed in ME allotted for maintenance (Table 1) but received equal allotments of ME for pregnancy and lactation. H-H-H = maintain a body condition score (BSC) of 5.5 from the second trimester until breeding; L-H-H = decline in BCS in the second trimester and reattain the BCS in the third trimester to match the H-H-H cows in weight and BCS at parturition; L-L-H = decline in BCS in the second trimester and reattain the BCS after 28 d of lactation to match the cows of the other two treatments.
[b]Body condition score is on a scale of 1 to 9.
[c,d]Within a row, means without a common superscript letter differ ($P < 0.05$).

Table 5. Calf body weights, kg

Days from birth	Treatment[a] H-H-H	L-H-H	L-L-H	$P < F$ Treatment	Sex Male	Female	$P < F$ Sex
0	44.5 ± 0.9[b]	43.3 ± 1.1[b]	39.8 ± 0.8[c]	0.001	45.4 ± 0.9	39.9 ± 0.5	<0.001
28	74.3 ± 1.5[b]	73.9 ± 1.5[b]	69.0 ± 1.3[c]	0.008	76.6 ± 1.3	68.9 ± 1.0	<0.001
58	101.9 ± 2.4	100.4 ± 2.2	99.9 ± 2.1	0.81	106.6 ± 1.9	96.0 ± 1.5	<0.001
205	224.6 ± 4.3	221.2 ± 5.1	217.2 ± 5.1	0.54	219.8 ± 4.4	221.9 ± 3.9	0.71

[a]Treatments differed in ME allotted for maintenance (Table 1) but received equal allotments of ME for pregnancy and lactation. H-H-H = maintain a body condition score (BSC) of 5.5 from the second trimester until breeding; L-H-H = decline in BCS in the second trimester and reattain the BCS in the third trimester to match the H-H-H cows in weight and BCS at parturition; L-L-H = decline in BCS in the second trimester and reattain the BCS after 28 d of lactation to match the cows of the other two treatments.
[b,c]Within a row, means without a common superscript letter differ ($P < 0.05$).

Selk et al. (1988) reported cows that cycled in weight had lower pregnancy rates than did cows fed to maintain weight. Those results differ from the findings of the current study. In both studies, cows in the weight cycling treatment and cows in the maintenance treatment entered breeding at a BCS between 5.0 and 5.3 at approximately 60 d after parturition. The studies differed in that the breeding season in the current study was 30 d shorter.

In the current study, total DMI during the last two trimesters did not differ between the H-H-H and L-H-H treatments; however, 406 Mcal of ME/cow was deferred from the second trimester to the third trimester in the L-H-H treatment. The H-H-H and L-H-H treatments did not differ in BW or BCS at parturition, suggesting the findings of no net difference in feed use between nonpregnant/nonlactating cows that either weight-cycled or were fed a constant amount of feed (Freetly and Nienaber, 1998) is applicable to the pregnant cow. Pregnancy rates and calf growth did not differ between the two treatments, suggesting that moderate feed restriction during the second trimester followed by additional feed in the third trimester is a potential management strategy for improving utilization of grazed forages. Because total feed intake over the test period was not reduced but daily intakes were deferred, production systems that rely on grazed forages need to synchronize forage availability and stocking rates with the need for increased feed intake in the third trimester.

Table 6. Average daily gain from 28 to 58 d after parturition

Treatment[a]	Cows, kg/d	Calves, kg/d
H-H-H	−0.21 ± 0.13[b]	0.91 ± 0.04[b]
L-H-H	−0.29 ± 0.21[b]	0.89 ± 0.05[b]
L-L-H	1.56 ± 0.21[c]	1.04 ± 0.04[c]
$P < F$ Treatment	0.001	0.02

[a]Treatments differed in ME allotted for maintenance (Table 1) but received equal allotments of ME for pregnancy and lactation. H-H-H = maintain a body condition score (BSC) of 5.5 from the second trimester until breeding; L-H-H = decline in BCS in the second trimester and reattain the BCS in the third trimester to match the H-H-H cows in weight and BCS at parturition; L-L-H = decline in BCS in the second trimester and reattain the BCS after 28 d of lactation to match the cows of the other two treatments.
[b,c]Within a column, means without a common superscript letter differ ($P < 0.05$).

By calving cows at light weights and increasing feed intake 28 d after parturition (L-L-H), feed consumed from the beginning of the second trimester to breeding was decreased by 468 Mcal of ME/cow. In the current study, cows that were refed beginning 28 d after parturition (L-L-H) tended to be heavier at a similar BCS at breeding than the other two treatments. Freetly and Nienaber (1998) found an extended period of N gain in mature nonpregnant/nonlactating cows that were allowed to gain weight after a period of weight loss. If the cows in the current study gained N in a manner similar to those in Freetly and Nienaber (1998), it would suggest that they would weigh more at a common BCS. At palpation, cow BW either did not differ or was greater than BW at the beginning of the second trimester, suggesting cows were able to recover their weight within an annual production cycle.

During the first 15 d after parturition, all cows lost BW. The weight loss during the first 15 d may result from a decrease in water balance and(or) tissue catabolism as the cow adapts from pregnancy to lactation. Although weight change over time did not differ among the treatments, there was a tendency for the cows in the L-L-H treatment to lose more weight than the other treatments, suggesting that maternal tissues may have been used in support of lactation. After feed intakes were increased in the L-L-H treatment, cow BW increased, suggesting that the cows were in a positive nutrient balance.

In the current study, cows that were refed 28 d after parturition did not differ from cows assigned other treatments in pregnancy rates at the end of breeding. These findings are consistent with those of Richards et al. (1986) and Houghton et al. (1990). Richards et al. (1986) reported a 92% pregnancy rate after a 60-d breeding season for cows that calved with BCS equal to or less than 3 and gained at least 0.07 kg/d after parturition. In their study, pregnancy rates (85%) of cows that were allowed to lose weight until 14 d before breeding (~45 d postpartum) did not differ from cows that were gaining weight after 60 d of breeding. In the current study, the L-L-H cows lost 36 kg over the first

28 d postpartum and subsequently gained 1.56 kg/d during the next 30 d. Houghton et al. (1990) reported cows that lost weight during pregnancy and gained weight after parturition had shorter postpartum intervals than cows that maintained weight during pregnancy and gained weight after parturition.

Birth weights of calves from cows on the L-L-H treatment were lower than those of the other treatments. These results suggest that feed restriction during late pregnancy reduced fetal growth. Houghton et al. (1990) reported that cows that calved with a BCS of ~4.7 had calves that were 4.3 kg lighter at birth than cows that calved with a BCS of ~5. In the current study, L-L-H cows had a BCS of 4.8 at parturition and lost 28 kg of maternal weight during the last trimester of pregnancy and their calves were 4.7 kg lighter at birth than calves from the H-H-H cows. Tudor (1972) reported a 6.8-kg decrease in birth weights of calves whose dams lost 36.8 kg during the last trimester compared with cows that gained weight during the last trimester. Wiltbank et al. (1962) observed a 5-kg reduction in the birth weight of calves born to cows with a BCS of 4.5 compared with those born to cows with a BCS of 6.7. Corah et al. (1975) reported a 2-kg reduction in birth weight of calves from heifers that lost 5.8 kg of BW during the last 100 d of gestation compared with cows that gained 36.1 kg. Bellows and Short (1978) reported 4.1-kg decrease in birth weight of calves from heifers that calved at a BCS of ~2.5 compared with heifers that calved at a BCS of ~5.5, but they did not observe a difference in the birth weights of calves from mature cows calving at low BCS. Bellows and Short (1978) may not have observed a reduced birth weight because the mature cows in low BCS in their study lost 8 kg during the last trimester, which is less severe than the 28-kg loss in our study and the 36.8-kg loss in the study of Tudor (1972).

Energy retention by the fetus and nutrient uptake by the gravid uterus are greatest during the last trimester (Ferrell et al., 1976; Reynolds et al., 1986), suggesting that nutritional restriction during this period is the most critical with respect to fetal growth. In the current study, cows that were restricted during the second trimester but allowed to gain weight during the third trimester (L-H-H) had calves that did not differ in weight at birth from cows that were fed at the high level (H-H-H). Other studies have also reported that birth weight was not reduced in light weight cows that were fed to gain weight in the third trimester (Corah et al., 1975; DeRouen et al., 1994; Morrison et al., 1999).

For the first 28 d, BW gain in calves was the same regardless of the nutritional environment of the dam. Because the cow's milk was the only food resource, the similar weight gains suggest that lactation level did not differ between the three treatments during the first 28 d. Similarly, the greater ADG (15%) in the calves from the L-L-H treatment from 28 through 58 d after birth suggest that the increased nutrient availability to the cow resulted in an increase in milk production. As a result of this increase in ADG, there were no differences in 58-d BW in the calves. After cows were placed in breeding pastures, nutrient availability did not differ among the treatments.

The results of this study suggest that weight cycling of mature beef cows between BCS that range from slightly moderate to good is potentially a viable management tool for decreasing feed cost. In the case of the L-L-H treatment, total feed intake was decreased; however, the output data should be viewed with some caution. The calves in the L-L-H treatment had lower birth weights than the H-H-H treatment, and, although not statistically different, the 205-d calf BW was numerically lower (7.4 kg) in these same calves. These results may be indicative of reduced potential growth of low-birth-weight calves. Other studies have reported lower weaning weights in calves that had low birth weights due to prenatal nutritional restriction of their mothers (Hight, 1966; Boyd et al., 1987). Similarly, pregnancy rates did not differ among the treatments, but the L-L-H treatment was numerically the lowest (88%). A number of studies have reported that pregnancy rates are dependent on the severity of feed restriction at parturition, the level of realimentation, the timing of realimentation relative to the beginning of breeding, and the length of the breeding season (Dunn and Kaltenbach, 1980; Richards et al., 1986; Selk et al., 1988; Osoro and Wright, 1992). The output performance of the H-H-H and L-H-H treatments were similar, suggesting that weight cycling can be used to improve the economic efficiency. These findings warrant economic evaluation in a production system to determine whether profitability can be increased by strategic management of feed resources.

Implications

Allowing mature cows to decrease to moderate body condition score during the second trimester of pregnancy and to regain the body condition score during the third trimester offers a potential management tool that modifies the time when feed resources are used without decreasing productivity.

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